Plan to Establish the SWIM Local Server and Test-bed for SWIM

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Summary
The existing aviation communications network has problems such as inefficient and restrictive use of information, restriction on flexible measures when an exceptional situation occurs and difficulties in applying new service. Because SWIM (System Wide Information Management) proposed as a remedy for this, combines several aviation communications networks and operates a data format composed of as a standard in the network structure using SOA (Service Oriented Architecture). SOA is a delivery system based on the internet protocol, where addition, change and exchange of service can be done easily and quickly. Therefore, countries advanced in the aviation industry such as the U.S. and Europe have been currently developing SWIM technology integrating existing aviation communication networks. In this paper, the plan for the SWIM network structure based on SOA considering the requirements of SWIM is presented. The SWIM local server for the interface of the SWIM network and the SWIM test-bed, which can study and test the SWIM network based on this, are proposed.

Key words:
SWIM, ASBU, AXIM, FIXM, WXXM

1. Introduction

The existing aviation communications network is operated independently using the system of interested parties by the network of the point-to-point mode and causes discordance among databases of each system since it does not use the standardized data. Therefore, fragmentary acquisition and restrictive use of information, inefficient operation of a service, difficulty in maintenance and repair and security problems have been introduced [1,2].

Due to these problems, countries advanced in the aviation industry such as the U.S and Europe have been researching SWIM (System Wide Information Management) which can provide data used in the aviation service, airport, etc quickly and precisely by integrating the existing aviation communications networks. SWIM means technology which changes voice and simple text oriented data used in the existing aviation communications system into various forms. It also integrates various aviation communications systems based on the internet protocol. Moreover change and exchange of service can be performed easily and quickly because it uses SOA (Service oriented Architecture) to organize and reuse dispersed abilities in the existing supply-oriented service [1].

Therefore, in this paper, the plan for SWIM test-bed based on SOA satisfying SWIM requirements, which needs to integrate the existing aviation communications network on basis of the standardized internet protocol and exchanges data, is presented. Also, the SWIM local server for the interface of the SWIM network and the SWIM test-bed, which can study and test the SWIM network based on this, are proposed.

The composition of this paper is as follows. In Chapter 2, the contents about SWIM and overseas trend are explained. In Chapter 3, requirements of SWIM and the network structure and test-bed according to the requirements of SWIM are suggested. In Chapter 4, the article is concluded.

2. SWIM related Study

2.1 ASBU

ASBU (Aviation System Block Upgrade) is made in the 37th session (2010) of the general meeting of ICAO (International Civil Aviation Organization) for the purpose of satisfying the global requirements for interoperability of airspace while maintaining the focus on the safety. ASBU is a system specifying a series of remedies which can be realized in the entire area to improve the performance of the ATM (Air Traffic Management) system. It is divided into 4 areas of PIA (Performance Information Area) as shown in Fig. 1. PIA is composed of 4 blocks of 5-year unit from 2013 to 2028 and each module is located in a block. The connection of modules between blocks is defined as Thread[3]. Fig. 2 represents the details of the global mutual operation system and data, which is PIA2 of ASBU. SWIM among those, as the contents of study conforming to B1-31 in Block 1, is the network technology managing aviation data comprehensively.

FF-ICE (Flight and Flow Information for a Collaborative Environment), the global ATM operational concept of ICAO, is defined to use the information of the collaborative ATM environment catching up with the internationalization. The goal of this FF-ICE is to establish the future ATM environment which uses the 4-D trajectory process. This process is to achieve the performance improvement of CDM and air lines by establishing the flight plan using the environment based on dynamic

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information. Information used at this time also includes information based on SWIM of PIA2[3,4,5].

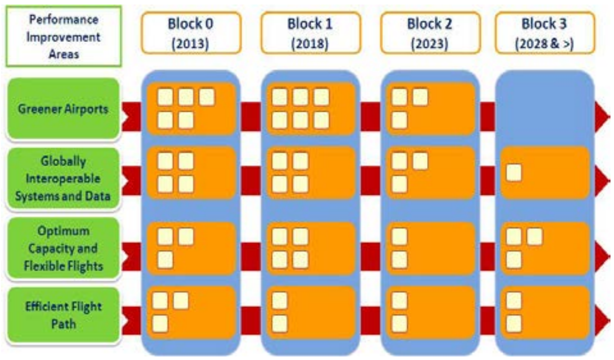
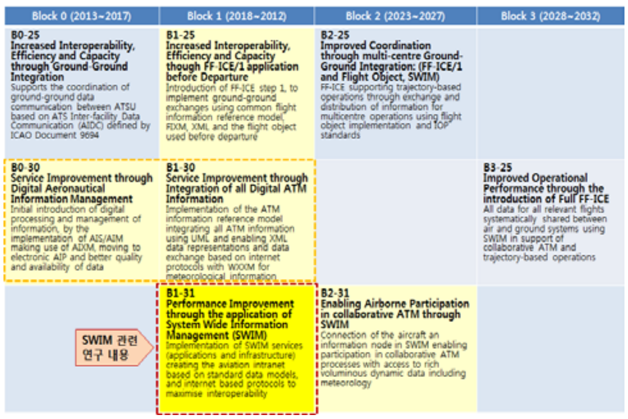


Fig. 1 Introduction of ASBU



Block 0 (2013~2017)	Block 1 (2018~2012)	Block 2 (2023~2027)	Block 3 (2028~2032)
B0-25 Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration Supports the coordination of ground-ground data communication between ATSU based on ATS Inter-facility Data Communication (AIDC) defined by ICAO Document 9694	**B1-25 Increased Interoperability, Efficiency and Capacity though FF-ICE/1 application before Departure** Introduction of FF-ICE step 1, to implement ground-ground exchanges using common flight information reference model, FIXM, XML and the flight object used before departure	**B2-25 Improved Coordination through multi-centre Ground-Ground Integration: (FF-ICE/1 and Flight Object, SWIM)** FF-ICE supporting trajectory-based operations through exchange and distribution of information for multicentre operations using flight object implementation and IOP standards	
B0-30 Service Improvement through Digital Aeronautical Information Management Initial introduction of digital processing and management of information, by the implementation of AIS/AIM making use of AIXM, moving to electronic AIP and better quality and availability of data	**B1-30 Service Improvement through Integration of all Digital ATM Information** Implementation of the ATM information reference model integrating all ATM information using UML and enabling XML data representations and data exchange based on internet protocols with WXXM for meteorological information		**B3-25 Improved Operational Performance through the introduction of Full FF-ICE** All data for all relevant flights systematically shared between air and ground systems using SWIM in support of collaborative ATM and trajectory-based operations
SWIM 관련 연구 내용	**B1-31 Performance Improvement through the application of System Wide Information Management (SWIM)** Implementation of SWIM services (applications and infrastructure) creating the aviation intranet based on standard data models, and internet based protocols to maximise interoperability	**B2-31 Enabling Airborne Participation in collaborative ATM through SWIM** Connection of the aircraft an information node in SWIM enabling participation in collaborative ATM processes with access to rich voluminous dynamic data including meteorology	

Fig. 2 Details of ASBU PIA2

2.2 SWIM

In the existing aviation communications network, there are the problems of the independent system due to the point-to-point mode network structure of interested parties of aviation, and due to the discordance with databases between each aviation-related organization, and because of discordances with the definition and use of standardized data. Accordingly problems exist, such as ineffective and restrictive use of information, restriction on flexible measures when an exceptional situation occurs, and difficulties in applying new service. Therefore, both the U.S and Europe have been currently studying SWIM technology which makes data used in aviation services and airports to be delivered quickly and exactly by integrating the aviation communications network [1,3,4].

The core of SWIM technology is to change voices and simple texts oriented data, used in the current aviation communications system, into the exchange model expandable to diverse forms. The new information exchange model provides the base which can efficiently and quickly process aviation information of diverse forms.

On one hand, SWIM means technology integrating many aviation communications networks based on the internet protocol as shown in Fig. 3. On the other hand, it breaks away from the concept which the existing point-to-point mode network simply delivers data and manages aviation data using SOA. When applying SWIM, it does not establish a new network but it operates as a message delivering system on the internet protocol network as shown in Fig. 4. Therefore, anyone can use aviation data by using the standardized data format. Indeed users or data providers exchange data using the data format consisted of standards. As the international standardized data format used by SWIM, there are AIXM (Aeronautical Information Exchange Model), the format related with aviation information among aviation data, FIXM (Flight Information Exchange Model), the data format to share information about flights, and WXXM (Weather Exchange Model), the data format conforming to weather [1].

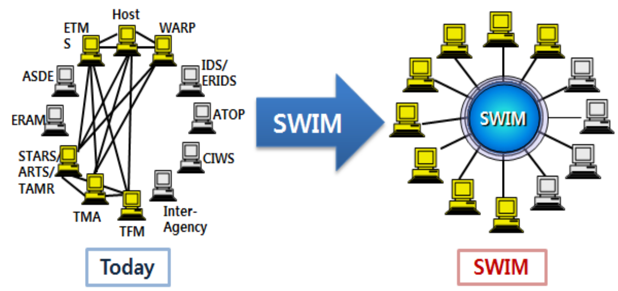


Fig. 3 Development of the Aviation Communications Network which SWIM is Applied.

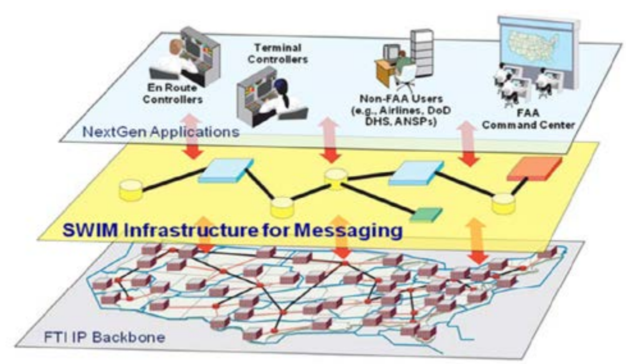


Fig. 4 Concept Graphic of SWIM

For the core service provided by SWIM in accordance with the aforementioned SWIM, there is the address/registration service first and it enables SWIM to request what kind of data it has and what kind of data it requires. The interface service means connecting own system to the SWIM network. For the broker service, it provides a function adjusting necessary information and giving possible information. The infrastructure adjustment service takes charge of end-to-end performance monitoring, situation adjustment, problem detection and solving, and the function of allocating and setting resources. The security service locates weaknesses of the system infrastructure and network, and preserves the

original form of data. It also monitors and adjusts the type, reason for usage, and frequency of data which the connecting system tries to use.
The advantages of SWIM is that it can minimize the design expenses at first by applying new technology, then by advancing the application time, and finally by promoting the improvement of operation such as common realization regarding the situation occurred, as shown in Fig. 5. It also can start service through reducing development expenses by connecting with a new application and using the open form and standardized interface. Standardization of service enables the reuse of information and allows a system of a different manufacturer to connect smoothly.

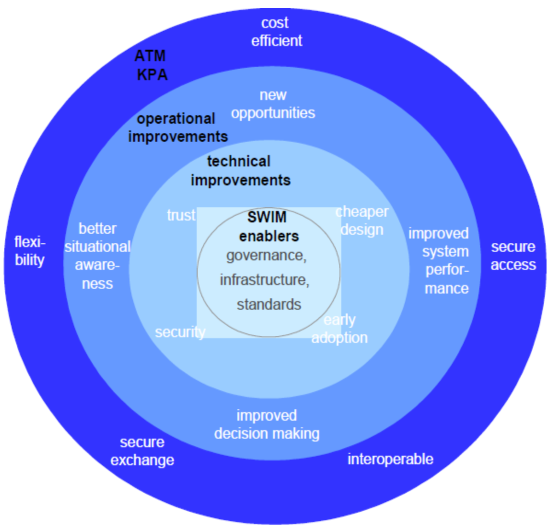


Fig. 5 Advantages of SWIM

2.3 SOA

SWIM provides many interested people of aviation an opportunity to easy access to necessary information. Therefore, in this paragraph, the definition and components of SOA are explained.
In the common definition of the word, service means producing/distributing produced commodities and providing works required to produce or consume. In other words, service can be defined as an activity which one component is provided through entering into an interface connection with another interface [6, 7].
SOA provides the framework effectively connecting a service provider and user, as an IT paradigm for organizing and using dispersed abilities. In other words, SOA can efficiently respond to business requirements changing rapidly because addition, change and exchange of service can be done easily and quickly in SOA by transforming service as a form which re-allotment is available. At this time, remote use and cross-platform use are the premise; however internal implementation matters are ignored.
The web service is the most typical technology to realize SOA. The web service, as an application of the self-describing module style, exposes the business logic as a form of service which posting, searching and summoning, through the internet are possible. This is the software system for interaction between different kinds of computers on the network. There are SOAP (Simple object Access Protocol), WSDL (Web Service Description Language) and UDDI (Universal Description, Discovery and Integration) as the web service protocol. All these messages are used as XML in the web service, the interoperability is high.
If a service provider registers his own service using the standard such as UDDI or WSDL in the service registry in SOA, a user can summon the relevant service using the same standard such as SOAP or WSDL by finding the service. And then, this can solve its requirements among services registered in the registry by using the same standard.
UDDI is the standard of publication, storage and discovery of service used in the web service, and UDDI defines the interface. This is the service registry defining the standard of SOAP message to discover and disclose the web service. Fig. 6 shows the pattern of how UDDI moves and UDDI plays a role in the service registry.

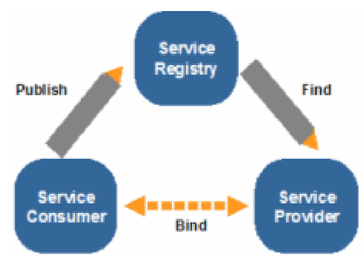


Fig. 6 Movement Pattern of UDDI

WSDL is the standard of service technology used in the web service. WSDL defines a message which will be received and sent by a service user and provider as XML and operates independently for every programming language.
SOA provides data required for the business process activity as the integrated service mode by integrating legacy applications [8]. Thus, a user is not required anymore to search related data after logging-in into multiple services and to combine results one by one manually. Also, only one log-in is necessary and it is displayed through a single screen and single application because a user directly assigns SOA service required for the business process activity.

2.4 Overseas Trend

The U.S has been promoting NextGen (Next Generation Air Transportation System). To carry out the expectation that the operation of airplanes in the US would increase more than 3 times by 2025, NextGen aims at improvement of the safety level of the future national airspace system, increase of the demand, reduction of environmental pollution, and fulfillment of the demand for operation of unmanned airplanes and commercial spaceships. Therefore, they are trying to improve the efficacy of every field related from an engine of an airplane to a cockpit, the entire airplane, and the airplane aviation management system. Regarding the core switching contents of NextGen, there are navigation and monitoring of the satellite base from the ground base, switch from voice communications to data communications, and maintenance of the normal flight status under the separated deteriorating weather or the area where the flight is difficult. For SWIM among core technologies, the primarily research and development related with SWIM led by FAA (Federal Aviation Administration) has been completed and data exchange has been succeeded by cooperating with European Eurocontrol after establishing the test-bed. In 2014, data linkage is being prepared for the mini global test and it is scheduled to start establishing the SWIM network in the U.S at the end of 2014. To develop this, service has been requested to Harris [9, 10].

The study to satisfy the demand of future aviation traffic and accomplish the single europe sky has been actively conducted in Europe by organizing SESAR (Single European Sky ATM Research). SESAR aims at development of the next generation ATM system securing the safety and efficiency of aviation system throughout Europe for the next 30 years. Regarding study and development contests related with SWIM, the common test-bed has been developed centering on FAA in the U.S and Eurocontrol, and mutual linkage test has been completed. Also, the SWIM master class linked to ATM has been run to vitalize the test-bed and relevant education has been progressed.

In East Asian countries, the study has been continued centering on the Asia-Pacific area office of ICAO. According to the result analyzing the volume of aviation traffic of the entire world for the past 10 years, a new structure which can guarantee the safety and efficacy of operation of airplanes has been strongly requested. Indeed the demand of the volume of aviation traffic has rapidly developed throughout the world. Therefore, provision of a more effective communications system has been required and Asian countries have started to establish ATM influenced by this. However, it is true that integration of the aviation communications network, which the concept of SWIM is applied, and the study on the middleware to use this have not been performed yet. In Japan, the study on the contents related with SWIM has been constantly conducted but there is no plan for the test-bed. In China, the SWIM project has been activated and they want to take the linkage test with Korea.

3. Plan to Establish the Test-bed

3.1 Requirements of SWIM

The purpose of SWIM is to establish the interface by integrating the system being operated previously so that management, access, and user's interface can be easy. The characteristics that should be accordingly considered are as follows. First, SWIM should be applicable without separate revision as it is linked to the legacy system. Second, stability and security of the system should be secured for normal operation of the aviation system. Third, expandability of the system can be regarded as an important problem due to the characteristic of not putting a limit on the linked service of the SWIM middleware. The major requirements according to these characteristics are as shown in Table. 1 [1].

Table 1: Requirements of the SWIM

Classification	Requirements
General	Generation of the standardized XML message format
	Inspection of efficacy of the standardized XML message format
	SOAP header components which can identify interested parties
	Standard SOAP Fault Process Function
	Error code transmitting function at the time of an error in the SWIM XML message format
	History recording function when sending and receiving a message
	Guarantee of operation in OS such as Window, Linux, etc
	Support of the SOA Request/Response message exchange pattern
	Support of the SOA Publish/scribe message exchange pattern
	Support of WS-Addressing specifications
	Support of WS-Security specifications
	Preparation for a case which the direct linkage with the legacy system is impossible
	Availability of operation in the SOAP 1.1/1.2 environment
	Provision of the service search function
	Provision of the service registration function
Data	Support of the FDD data exchange function
	Support of the SDD data exchange function

	Support the AID data exchange function
	Support of the weather data exchange function
Security	XML electronic signature module supporting ARIA and SEED codified algorithm
	Support of the security technology based on the certificate recommended by ICAO
	Support of the PKI function processing the certificate for electronic signature

3.2 Proposed SWIM Network Structure

The plan for the SOA structure of SWIM in accordance with characteristics and requirements written in Chapter 3.1, which SWIM should considerate, is appeared as shown in Fig. 7. The proposed plan for the SOA structure divides data and service provided by the previously operated system into independent small units and it links those to Enterprise Service Bus. Therefore, Enterprise Service Bus becomes to be responsible for functions such as service combination, user verification/security, etc. This can be the simplest form and dispersion-type structure established, because this performs only the unit function of aviation related to information service. Reuse and flexibility, processes of aviation service, are also available according to the design of Enterprise Service Bus.

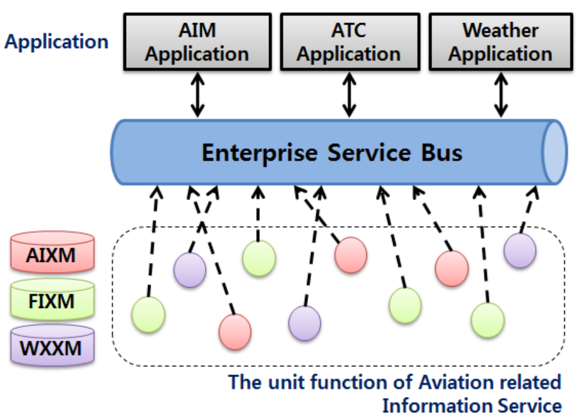


Fig. 7 The Plan for the SOA Structure of SWIM

Fig. 8 shows the plan for the SWIM network structure based on the SOA structure using such Enterprise Service Bus. The interface between the previously operated system and SWIM network uses the SWIM local server and the SWIM network exchange. It also connects the service with the aviation related information through the logical connection among SWIM local servers. Numerous legacy systems can be connected to the SWIM local server. When connecting to the legacy system, which does not use the standard data format, legacy system is connecting to the SWIM local server after processing to the standard data format by applying an adapter between the SWIM local server and legacy system.

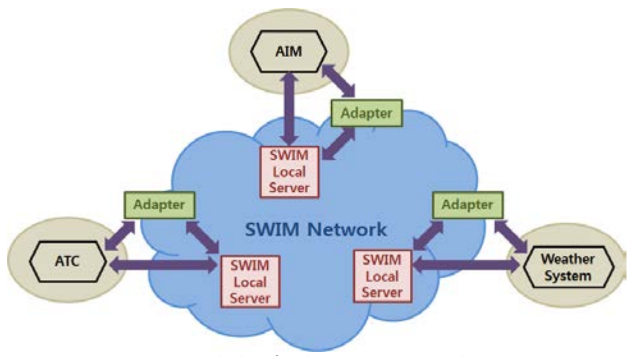


Fig. 8 Suggested Plan for the SWIM Network Structure

3.3 Suggested SWIM local server

The SWIM local server is used for the interface of the SWIM network within the SWIM network structure in Chapter 3.2 and should be designed by considering requirements mentioned in Chapter 3.1. Therefore, analyzed contents and designed plan for the core function of the SWIM local server are proposed.

The SWIM local server requires the following several core functions in terms of sending and receiving, and operation of data. First, the SWIM local server requires the standard XML generating function. Standard XML means the subject information itself which puts its purpose in exchanging. The function generating standard XML such as AIXM/FIXM/WXXM must be included in the SWIM local Server because every information exchange in SWIM is transmitted in the standard XML form as explained in Chapter 2.2. In the SWIM local server, when sending data, a message in XML form is generated and located in the part of BODY of an actual SOAP message.

Meanwhile, as shown in Fig. 9, the SOA communications module is consisted of internal modules of the SWIM local server and it performs the function related with SOA communications as these are organically composed of the SOA communications module. Largely, there are two internal modules which are consisted of SOA communications modules. First, the Request/Response module is the module for communications among SWIM local servers and this module applies the method, constituent the Request/Response module, using the web service. Therefore, when one SWIM local server requests information to another SWIM local server, the SWIM local server, which receives this request, answers for the request. Next, the Publish/Subscribe model is the module for distributing data related with an airplane entity. The module is realized by using PSS (Portable Subscriber Station) components so that information of an airplane, defining the structure of data related with an airplane entity, can be disclosed and received. Thus, it can have a service form which directly publishes and subscribes a specific service to an adapter or legacy system without going through components of a specific data domain.

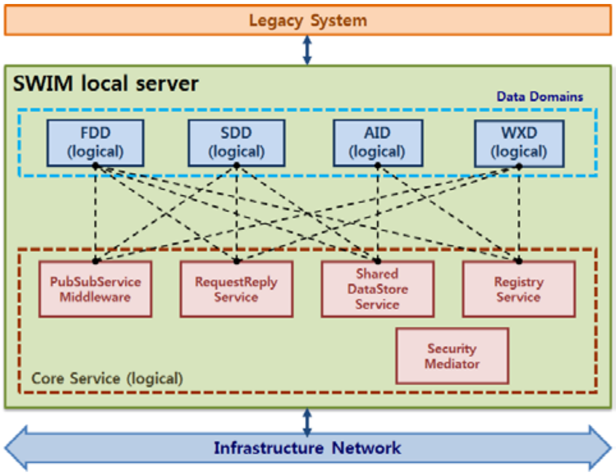


Fig. 9 Existing data providing system Infrastructure Network

The service management and user terminal management modules use the UDDI registry server. UDDI is the specification defining the method to disclose and search information about the web service. It includes the XML file and its web service describing the UDDI service registration and service list. Therefore, it is very appropriate for SWIM using SOAP and XML. The program for service management and user terminal management is made using the jUDDI (java UDDI) program because the jUDDI program should be used to utilize the UDDI registry server.
Lastly, the security module is the module required to prevent forgery, forge, and falsification of data when transmitting data. As the security model of the suggested SWIM local server, the data codification and SW-Security specification are applied. Because WS-Security is the specification for the web service applying security to SOAP, it is required to follow the SW-Security specifications to employ a protocol necessary to apply security to SOAP.

3.4 Proposed SWIM Test-bed

The test-bed, which can perform the simulation for the SWIM local server proposed in Chapter 3.3 and analyze its result, is proposed as shown in Fig. 10. The legacy system of the proposed test-bed is consisted of 4 servers by adding initial data considered by SWIM having AXIM/FIXM /WXXM servers and one more relevant sensor. The legacy system connects each adapter under the presumption that a message in the standard XML form will not be used. It changes the message to the data format used in the same SWIM with AXIM/FIXM/WXXM. These adapters are connected to the SWIM local server. The Fig. 10 shows the shape of these adapters being connected with different SWIM local servers. However, the proposed SWIM local server can connect several legacy systems in some cases because it is designed in a way that several legacy systems can be connected to one SWIM local server. These SWIM local servers are connected to one network by combining UDDI (which is playing a role of the service registry) and user as the switch. This network was composed to go through a gateway to connect with the overseas SWIM network.

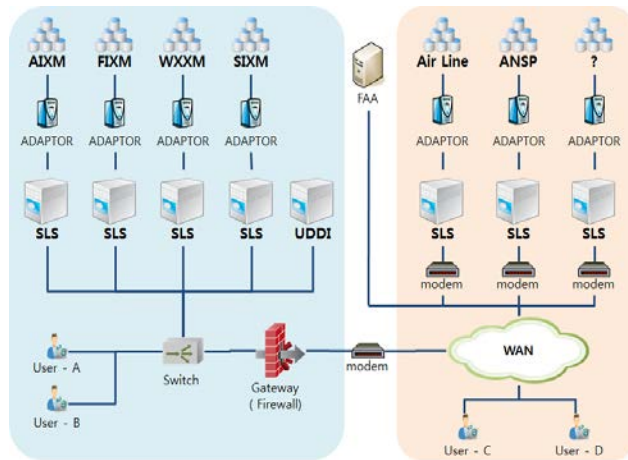


Fig. 10 Shape of the Suggested SWIM Test-bed

4. Conclusion

This paper described about SWIM, one of B1-31 of ASBU which is the remedy to solve problems of the existing aviation communications network. Therefore, the plan for the SWIM network structure based on SOA according to the requirements and the SWIM local server for the interface of the SWIM network were proposed. Then the SWIM test-bed, which can study and test the SWIM network based on SWIM local server and models, was suggested.
There are effects, one is using various information with less information fees by establishing SWIM with the suggested test-bed, and another effect is adding new information to the aviation communications network which makes it easier. Also, efficacy for the general situation analysis would increase, skills responding to the change of new aviation technology would improve, and information exchange capability between other countries would also increase. It would also contribute to preoccupancy of competitiveness of aviation communications and securement of the export market through global standardization of SWIM technology.

Acknowledgment

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